FINAL
ECOLOGICAL RISK ASSESSMENT

COEUR D'ALENE BASIN REMEDIAL INVESTIGATION/FEASIBILITY STUDY

Prepared by
CH2M HILL
777 108th Avenue NE
Bellevue, Washington 98004

and

URS Corp.
1501 Fourth Avenue, Suite 1400
Seattle, Washington 98101-1616

Prepared for
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Region 10
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Seattle, Washington 98101
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Dedication

Don Heinle

March 23, 1937 - January 17, 2001

The Coeur d'Alene Basin Ecological Risk Assessment is dedicated to the memory of noted aquatic ecologist and biologist Don R. Heinle, Ph.D., for his contributions to this report and the overall Coeur d'Alene Basin Remedial Investigation/Feasibility Study. Don Heinle's vast knowledge and understanding gained from over 40 years of experience working on environmental projects in this country and overseas was invaluable in developing the Conceptual Site Model and risk assessment methodologies presented in this report. He will be remembered for his intelligence, integrity, humility, sense of humor, and dedication to valuing and preserving the quality of our environment.

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ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

µg/g	Micrograms per gram
µg/L	Micrograms per liter
Ag	Silver
ALAD	Aminolevulinic acid dehydratase
ARARs	Applicable or relevant and appropriate requirements
As	Arsenic
AVS	Acid volatile sulfides
AWQC	Ambient water quality criteria
BAF	Bioaccumulation factor
bgs	Below the ground surface
BLM	Bureau of Land Management
BURP	Beneficial Uses Reconnaissance Program
CAC	Citizens' Advisory Committee
Cd	Cadmium
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CIA	Central Impoundment Area
COEC	Chemical of ecological concern
COPC	Chemical of potential concern
COPEC	Chemical of potential ecological concern
CSM	Conceptual site model
Cu	Copper
EC_{20}	Effective concentration – 20 percent response
EC_{50}	Effective concentration – 50 percent response
EcoRA	Ecological risk assessment
$ED2_0$	Effective dose – 20 percent response
ED_{50}	Effective dose – 50 percent response

EPA	U.S. Environmental Protection Agency
EPC	Exposure point concentration
ER-L	Effects range-low
ER-M	Effects range-median
ESA	Endangered Species Act
FS	Feasibility study
ha	Hectare
Hg	Mercury
HQ	Hazard quotient
HSI	Habitat Suitability Index
IDFG	Idaho Department of Fish and Game
ISQG	Interim sediment quality guideline
LC	Lethal concentration
LC_{50}	Median lethal concentration
LD	Lethal dose
LOAEL	Lowest observed adverse effects level
LOEC	Lowest observed effects concentration
LOEL	Lowest observed effects level
mg/kg	Milligrams per kilogram
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No observed adverse effects level
NOEC	No observed effects concentration
NOEL	No observed effects level
NRDA	Natural Resource Damage Assessment
NWI	National Wetland Inventory
ORNL	Oak Ridge National Laboratory
Pb	Lead

PCB	Polychlorinated biphenyl
ppm	Parts per million
ppb	Parts per billion
PRG	Preliminary remedial goal
RI	Remedial investigation
RI/FS	Remedial investigation/feasibility study
ROD	Record of decision
T&E	Threatened and endangered
TEL	Threshold effects level
TRV	Toxicity reference value
UCL	Upper confidence limit
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WDFW	Washington Department of Fish and Wildlife
XRF	X-ray fluorescence
Zn	Zinc

GLOSSARY OF TERMS

Adverse ecological effects	Changes that are considered undesirable because they alter valued structural or functional characteristics of ecosystems or their components. An evaluation of adversity may consider the type, intensity, and scale of the effect as well as the potential for recovery.
Agent	Any physical, chemical, or biological entity that can induce an adverse or beneficial response (synonymous with stressor, but more general).
Agricultural	Land use (within the floodplain of CSM Unit 3) where pastures and hay fields, etc., provide wildlife habitat.
Ambient media toxicity test	A toxicity test conducted with environmental media (soil, sediment, water) from a contaminated site.
Aquatic	Relating to, growing in, or living in water.
Assessment endpoint	An explicit expression of the environmental value to the protected. An assessment endpoint must include an entity and specific attribute of that entity. Criteria for selection include ecological relevance, political/societal relevance, and susceptibility to known or potential pollutants.
Assessor	An individual involved in the performance of a risk assessment.
Attribute	A quality or characteristic of an ecological entity. An attribute is one component of an assessment endpoint.
Background concentration	The concentration of a substance in environmental media that are not contaminated by the sources being assessed. Background concentrations are due to naturally occurring substances and other anthropogenic metals sources unrelated to mining (e.g., leaded gasoline emissions from cars).
Bioaccumulation	The net accumulation of a substance by an organism due to uptake from all environmental media, including food.
Bioassay	A laboratory test using plants or animals to evaluate the effects of chemicals in an exposure medium (i.e., soil, water, sediment) on their survival, growth, or other biological response.

Bioavailability	The extent to which the form of a chemical occurring in a medium is susceptible to being taken up by an organism. A chemical is said to be bioavailable if it is in a form that is readily taken up (e.g., dissolved organic matter).
Bioconcentration	The net accumulation of a substance by an organism due to uptake from aqueous solution.
Biosurvey	A process of counting or measuring some property of biological populations or communities in the field. An abbreviation of biological survey.
Biota	Living organisms, including plants and animals.
Canopy cover	A measure of the degree to which the surface is covered by aboveground vegetation. It is related to the interception of solar radiation.
Chemicals of potential ecological concern	Chemicals that are believed to be site-related contaminants and to potentially pose a risk to ecological endpoint receptors.
Chlorosis	An abnormally yellow color of plant tissues resulting from loss of or partial failure to develop chlorophyll.
Community	An assemblage of populations of plants, animals, and microbes occupying the same area at the same time. However, the term is commonly used to refer to a subset of the community such as the fish community or the benthic macroinvertebrate community.
Conceptual model	A representation of the hypothesized causal relationship between the source of contamination and the responses of the endpoint entities. The conceptual site model describes contaminant releases, fate and transport, and potential pathways and routes of exposure to humans and ecological receptors.
Contaminant	A substance that is present in the environment due to release from an anthropogenic source and is believed to be potentially harmful.
Cumulative distribution function (CDF)	Cumulative distribution functions are graphic presentations used for describing the likelihood that a variable will fall within different portions of the overall range of values.
Direct effect	An effect resulting from an agent acting on the assessment endpoint or other ecological component of interest itself, not through effects on other components of the ecosystem (see indirect effect).

EC_{20}	A statistically or graphically estimated concentration that is expected to cause one or more specified effects in 20 percent of a group of organisms under specified conditions.
EC_{50}	A statistically or graphically estimated concentration that is expected to cause one or more specified effects in 50 percent of a group of organisms under specified conditions.
ED_{20}	A statistically or graphically estimated dose that is expected to cause one or more specified effects in 20 percent of a group of organisms under specified conditions.
ED_{50}	A statistically or graphically estimated dose that is expected to cause one or more specified effects in 50 percent of a group of organisms under specified conditions.
Ecological effects characterization	A portion of the analysis phase of the ecological risk assessment that evaluates the ability of a stressor(s) to cause adverse effects under a particular set of circumstances.
Ecological entity	A general term that may refer to a species, a group of species, an ecosystem function or characteristic, or a specific habitat. An ecological entity is one component of an assessment endpoint.
Ecological management goals	Statement of the desired ecological conditions for the site. They are established based on a realistic assessment of the current status of the ecological community and potential current and future land uses at the site.
Ecological receptors	Aquatic and terrestrial plants and animals that may be exposed to chemicals of potential ecological concern (see also **representative species**).
Ecological relevance	One of the three criteria for assessment endpoint selection. Ecologically relevant endpoints reflect important characteristics of the system and are functionally related to other endpoints.
Ecological risk assessment	A process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more agents.
Ecosystem	The functional system consisting of the biotic community and abiotic environment occupying a specified location in space and time.
Effects range-low (ER-L)	The lower 10th percentile of effects concentrations in coastal marine and estuarine sediments (NOAA).

Effects range-median (ER-M)	The median effects concentration in coastal marine and estuarine sediments (NOAA).
Embeddedness	Measure of the degree to which rocks and snags are covered or sunken into the silt, sand, or mud of the stream bottom.
Endpoint entity	An organism, population, species, community, or ecosystem that has been chosen for protection. The endpoint entity is, along with the endpoint property, a component of the definition of an assessment endpoint.
Eutrophic	Nutrient-rich waters characterized by abundant plant growth and frequent algal blooms.
Exposure	The contact or co-occurrence of a contaminant or other agent with a receptor.
Exposure characterization	A portion of the analysis phase of the ecological risk assessment that evaluates the interaction of the stressor with one or more ecological entities. Exposure can be expressed as co-occurrence or contact, depending on the stressor and ecological component involved.
Exposure pathway	The physical route by which a contaminant moves from a source to a biological receptor. A pathway may involve exchange among multiple media and may include transformation of the contaminant.
Exposure point concentration (EPC)	A concentration to which ecological receptors would most likely be exposed.
Exposure route	The means by which a contaminant enters an organism (e.g., inhalation, ingestion).
External exposure	Exposures of animals as a result of intake of contaminated media or food through ingestion, inhalation, or dermal contact (see **internal exposure**).
Feasibility study	The component of the CERCLA assessment process that is conducted to analyze the practicality, benefits, costs, and risks associated with remedial alternatives.
Functional ecosystem	Considered to exist if soil, sediment, water quality, food source, and habitat conditions are capable of supporting natural populations of plants and animals; there are no direct adverse effects on migratory birds or special-status species; and habitat conditions are conducive to recovery of special-status species.

Geographic information systems	Software that uses spatial data to generate maps or to model processes in space; commonly abbreviated as GIS.
Hazardous substance	Any element, compound, mixture, solution, or substance designated pursuant to the Superfund law (Section 102 of CERCLA); examples include lead, zinc, cadmium.
Health	Adverse sublethal effects caused by mining-related wastes that may be reasonably expected to impair survival (e.g., through increased susceptibility to disease or other causes of mortality and/or reproduction).
Herbaceous	Flowering plants (excluding grasses) that have little or no woody tissue and usually persist for a single growing season.
Indirect effect	An effect resulting from the action of an agent on components of the ecosystem, which in turn affect the assessment endpoint or other ecological component of interest (see **direct effect**). Indirect effects of chemical contaminants include reduced abundance due to toxic effects on food species or on plants that provide habitat structure.
Internal exposure	Exposures of animals as measured by COPEC concentrations in the receptor's tissues (see **external exposure**).
Invertebrates	Animals that lack a spinal column, such as insects, crayfish, and worms.
Lacustrine	Includes wetlands and deepwater habitats that occur in depressions (such as the lateral lakes and Coeur d'Alene Lake) or dammed river channels (such as Long Lake).
Line of evidence	A set of data and associated analysis that can be used, alone or in combination with other lines of evidence, to estimate risks. Each line of evidence is qualitatively different from any others used in the risk characterization. In ecological risk assessments of contaminated sites, the most commonly used lines of evidence are (1) biological surveys, (2) toxicity tests of contaminated media, and (3) toxicity tests of individual chemicals.
Lowest observed adverse effects level (LOAEL)	The lowest level of exposure to a chemical in a test that causes statistically significant differences from the controls in any measured response.
Macroinvertebrates	Invertebrate animals that are easily visible without magnification.

Measure of ecosystem and receptor characteristics	Measures that influence the behavior and location of ecological entities of the assessment endpoint, the distribution of a stressor, and life-history characteristics of the assessment endpoint or its surrogate that may affect exposure or response to the stressor (equivalent to one type of **measurement endpoint**).
Measure of effect	A measurable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint (equivalent to one type of **measurement endpoint**).
Measure of exposure	A measurable characteristic of a contaminant or other agent that is used to quantify exposure (equivalent to one type of **measurement endpoint**).
Measurement endpoint	See **measure of effect**, **measure of exposure**, and **measure of ecosystem and receptor characteristics**.
Media toxicity test	A toxicity test of water, soil, sediment, or biotic medium that is intended to determine the toxic effects of exposure to that medium.
Median effect concentration (EC_{50})	A statistically or graphically estimated concentration that is expected to cause a prescribed effect in 50 percent of a group of organisms under specified conditions.
Median lethal concentration (LC_{50})	A statistically or graphically estimated concentration that is expected to be lethal to 50 percent of a group of organisms under specified conditions.
Medium	The environmental medium is the substance or portion of the environment in which contaminants may be found, such as water or soil. Plural: media.
Micrograms per liter (µg/L)	Units used to measure contaminants in water. This measurement is equivalent to parts per billion (ppb). A µg/L is one thousand times less than a mg/L (part per million). To convert µg/L to mg/L (ppb to ppm), divide by 1,000.
Milligrams per kilogram (mg/kg)	Unit used to measure contaminants in soil (equivalent to parts per million). A mg/kg is one thousand times greater than a µg/kg (part per billion). To convert mg/kg to µg/kg (ppm to ppb), multiply by 1,000.

Natural Resource Trustees	Agencies designated by Executive Order 12580 and the NCP (300.600) as Federal trustees for natural resources (including Secretaries of the Departments of the Interior, Commerce, Defense, and Agriculture), as well as State and tribal officials designated by the NCP (300.605 - .610). (These trustees participated in the EcoRA Work Group, as described in text – see Section 1.0)
No observed adverse effect level (NOAEL)	The highest level of exposure to a chemical in a test that does not cause statistically significant differences from the controls in any measured response.
Oligotrophic	Nutrient-poor waters with low plant productivity and high transparency.
Palustrine	Wetland habitats that are dominated by trees, shrubs, and other persistent emergent wetland plants.
Phytotoxicity	Toxicity to plants.
Population	An aggregate of interbreeding individuals of a species occupying a specific location in space and time.
Preliminary remedial goal (PRG)	A contaminant concentration, toxic response, or other criterion identified from the risk assessment that is provided to risk managers to assist in making decisions for remedial action (see also **remedial goal**). For chemical stressors, the PRGs are proposed concentrations of metals in soil, sediment, and surface water below which adverse effects are expected to be absent or within defined limits.
Probable effects level (PEL)	The geometric mean of the 50th percentile of effects concentrations and the 85th percentile of no effects concentrations in coastal and estuarine sediments (Florida Department of Environmental Protection).
Problem formulation	The phase in an ecological risk assessment in which the goals of the assessment are defined and the methods for achieving those goals are specified.
Receptor	An organism, population or community that is exposed to contaminants. Receptors may or may not be assessment endpoint entities.
Record of decision (ROD)	The document presenting the final decision regarding selection of a remedial action, and justifying the decision on the basis of the results of the remedial investigation and feasibility study.

Recovery	The return of a population, community, or ecosystem process to a previous, valued state. Due to the complex and dynamic nature of ecological systems, the attributes of a "recovered" system must be carefully defined.
Reference value	A chemical concentration or dose that is a threshold for toxicity or significant contamination.
Release	The movement of a contaminant from a source to an environmental medium.
Remedial action objective	A specification of contaminants and media of concern, potential exposure pathways, and cleanup criteria (see **remedial goal**).
Remedial goal	A contaminant concentration, toxic response, or other criterion that is selected by the risk manager to define the condition to be achieved by remedial actions.
Remediation	Actions taken to reduce risks from contaminants including removal or treatment of contaminants and restrictions on land use. Remediation is the goal of the CERCLA RI/FS process. Note that, in contrast to restoration, remediation focuses on reducing risks from contaminants and may actually reduce environmental quality.
Representative species	Ecological receptors chosen within a trophic level to represent many other species with similar feeding habits.
Riparian	Occurring in or by the edge of a stream (including its floodplain) or a lake.
Risk assessment	An evaluation of the actual or potential threat to human health and the environment if no remedial action is taken.
Risk assessor	An individual engaged in the performance of the technical components of risk assessments. Risk assessors may have expertise in the analysis of risk or specific expertise in an area of science or engineering relevant to the assessment.
Risk characterization	A phase of ecological risk assessment that integrates the exposure and stressor response profiles to evaluate the likelihood of adverse ecological effects associated with exposure to the contaminants.
Risk management	The process of deciding what remedial or restoration actions to take, justifying the decision, and implementing the decision.

Risk manager	An individual with the authority to decide what actions will be taken in response to a risk. Usually risk managers are representatives of regulatory agencies, land managers, or other organizations.
Riverine	The habitat within streams.
Single-chemical toxicity test	A toxicity test of an individual chemical administered to an organism or added to soil, sediment, or water to which an organism is exposed.
Source	An entity or action that releases contaminants or other agents into the environment (primary source) or a contaminated medium that releases the contaminants into other media (secondary source). Examples of primary sources for contaminated sites include spills, leaking tanks, dumps, and waste lagoons.
Special-status species	Those species designated as "endangered," "threatened," or "species of concern" by the U.S. Fish and Wildlife Service (Federal listed); those designated as "sensitive species" by state agencies; and those identified as having cultural significance.
Stakeholders	Individuals or organizations that have an interest in the outcome of a remedial action but are not officially parties to the decision making. Examples include natural resource agencies and citizens groups. A somewhat clearer synonym is "interested parties."
Terrestrial	Plants or animals living in upland ecosystems not associated with water.
Threshold effects level (TEL)	The geometric mean of the 15th percentile of effects concentrations and the 50th percentile of no effects concentrations in coastal and estuarine sediments (Florida Department of Environmental Protection).
Toxicity	The harmful effects produced by exposure of an organism to a chemical.
Toxicity Reference Value (TRV)	A concentration or dosage of a chemical that results in a specified effect (or no effect). This value may be obtained from literature, site-specific toxicity tests, or field surveys, or may be derived through probabilistic modeling.
Trophic levels	A functional classification of taxa within a community that is based on feeding relationships (e.g., aquatic and terrestrial green plants make up the first trophic level and herbivores make up the second).
Uptake	The process by which a chemical is incorporated into an organism.

Uptake factor	The quotient of the concentration of a chemical assimilated in an organism divided by the concentration in an environmental medium.
Weight of evidence	A type of analysis that considers all available evidence and reaches a conclusion based on the amount and quality of evidence supporting each alternative conclusion, or the result of a weight-of-evidence analysis.
Wetland	An area that has a combination of soil characteristics (referred to as "hydric" soils), vegetation (such as cattails or sedges), and periods of inundation by water that facilitates habitat for aquatic organisms and/or water-related wildlife.
X-ray Fluorescence (XRF)	A method of testing for metals in which a sample is irradiated with a beam of x-rays.

EXECUTIVE SUMMARY

This document presents the results of the ecological risk assessment (EcoRA) for aquatic and terrestrial organisms exposed to hazardous substances associated with mining activities in the Coeur d'Alene River basin in Idaho and the (downstream) Spokane River in Washington (see further description of the study area below). The EcoRA evaluates potential threats to the environment in the absence of any remedial action. It identifies and characterizes the toxicity of chemicals of potential ecological concern (COPECs), possible exposure pathways, ecological receptors, assessment and measurement endpoints, and a range of possible risks under current conditions. These aspects of the document are explained in the various sections and are summarized below.

The U.S. Environmental Protection Agency (EPA) established the Coeur d'Alene Basin Ecological Risk Assessment Work Group (EcoRA Work Group) to provide an avenue for stakeholder input during development of the EcoRA. Membership in the EcoRA Work Group was open to any parties who expressed an interest and asked to be included. Using regularly scheduled teleconferences and milestone meetings, the EcoRA Work Group provides a forum by which interested parties can be involved early and often. Groups to which information was provided include the State of Idaho, State of Washington, Coeur d'Alene Tribe, Spokane Tribe, Colville Tribe, U.S. Fish and Wildlife Service, and other governmental partners, public interest group members, newspaper reporters, legislative staffers, mining company representatives, and other parties.

PURPOSE OF THE ECOLOGICAL RISK ASSESSMENT

The Coeur d'Alene Basin EcoRA has been prepared as part of the Coeur d'Alene Basin Remedial Investigation/Feasibility Study (RI/FS). The purpose of the EcoRA is to describe the likelihood, nature, and severity of adverse effects to plants and animals resulting from the hazardous substances released by the mining activities in the Coeur d'Alene River basin under current and future land uses (which are assumed to be similar to current land uses). Risk managers will use the results of the EcoRA, along with other relevant information, to make decisions regarding remedial cleanup activities that may be needed to protect the environment.

SCOPE OF THE ECOLOGICAL RISK ASSESSMENT

The EcoRA study area includes the Coeur d'Alene River and associated tributaries, Coeur d'Alene Lake, and the Spokane River downstream to the Washington State Highway 25 bridge at Fort Spokane on the Spokane Arm of Lake Roosevelt (Figure ES-1).[a] Collectively, this area is referred to as the Coeur d'Alene Basin. The specific portion of the study area upstream of Coeur d'Alene Lake (which includes the South Fork Coeur d'Alene River [hereafter referred to as the South Fork], portions of the North Fork Coeur d'Alene River [hereafter referred to as the North Fork], the main stem of the Coeur d'Alene River [hereafter referred to as the main stem], associated tributaries, and the Lateral Lakes area) is usually referred to as the Coeur d'Alene

[a] All figures within a section immediately follow the text for that section.

River basin. (Coeur d'Alene Lake and the upstream watershed were originally the extent of the study area, but the Spokane River was subsequently added without a change in the project name. The potential for confusion is recognized, so the project area definition is reiterated in each section of this document.)

The study area was divided into five units (called conceptual site model [CSM] Units) that were differentiated based on geomorphology, mixes of hazardous substances, and habitats (Figures ES-2 and ES-3). As a result of differences in habitats among the CSM units, the ecological receptors also vary, as discussed below in the environmental setting section. The CSM units are discussed in Section 2.6 and are briefly described here.

CSM Unit 1 contains many of the primary sources for mining-related hazardous substances (metals) including mine workings, waste rock and other mining waste, mine tailings, concentrates, and other process wastes, and artificial fill (tailings and waste rock in roads, railroads, and building foundations). CSM Unit 1 includes the upper watershed of the South Fork (above Wallace) and associated creeks (Canyon Creek and Ninemile Creek). It also includes Prichard Creek, Beaver Creek, Moon Creek, Big Creek, and Pine Creek, all of which discharge to the North Fork or downstream of Wallace into the South Fork.

CSM Unit 2 contains the remainder of the primary sources of mining-related hazardous substances within the surface water and sediments of mid-gradient streams and small tributaries within the main stem watershed downstream to Cataldo. Most of the Bunker Hill Superfund Site is in CSM Unit 2. The primary sources within this CSM unit are similar to those in CSM Unit 1.

CSM Unit 3 consists of the low-gradient part of the main stem, from the Old Highway Bridge at Cataldo to Coeur d'Alene Lake. It includes the lateral lakes that occur within the floodplain of the river. Mining-related hazardous substances within this CSM unit are found in the beds and banks of the river, contaminated floodplain soils, surface water, groundwater, and biota (plants and animals) that have accumulated metals.

CSM Unit 4 consists of Coeur d'Alene Lake, where mining-related hazardous substances include contaminated sediments and surface water. In addition, nutrients are of significant concern because they can change the trophic status of the lake and can cause secondary releases of metals from contaminated sediments.

CSM Unit 5 consists of the Spokane River. Mining-related hazardous substances are found mainly in contaminated sediments and surface water.

ECOLOGICAL RISK ASSESSMENT PROCEDURE

The EcoRA includes three main phases: Problem Formulation, Analysis, and Risk Characterization; these phases are described in subsequent sections of the document and are described briefly here:

- **Section 2.0 - Problem Formulation** describes the site background and ecological setting; discusses selection of ecological management goals, assessment endpoints,

and measures; identifies COPECs; evaluates background metals concentrations; and describes the ecological CSM for each CSM unit.

- **Section 3.0 – Analysis** includes the exposure characterization and ecological effects characterization, as follows:

  – ***Exposure Characterization*** evaluates various sources including a discussion of the spatial and temporal distribution of chemical stressors; describes exposure assumptions and models for each receptor group; and presents the exposure estimates for each representative species.

  – ***Ecological Effects Characterization*** presents the chemical stressor-response analyses including literature-derived and site-specific toxicity information for each COPEC, site-specific ambient media (e.g., surface water or soil-sediment) toxicity tests, and site-specific field surveys.

- **Section 4.0 - Risk Characterization** presents the risk estimation and risk description for chemical and physical stressors in each CSM unit. It also summarizes the uncertainties and limitations associated with the risk assessment data, approach, and evaluations conducted.

- **Section 5.0 – Conclusions and Ecological Preliminary Remedial Goals** presents the overall conclusions of the EcoRA (as related to the assessment endpoints and representative species identified during the Problem Formulation), along with Preliminary Remedial Goals (PRGs). The PRGs represent concentrations of COPECs that would result in acceptable levels of risk (including no risk or risk within defined limits) for various ecological receptors, and the physical habitat conditions that would be conducive to recovery of the affected receptor populations. In addition, a summary of the EcoRA and a brief discussion of the use of the EcoRA results in the RI decision process are presented.

- **Section 6.0 – References** lists the references that were cited throughout the various portions of the EcoRA text and appendices.

- **Appendices –** include various supporting materials used to prepare the EcoRA text.

PROBLEM FORMULATION

Site History

Mining began in the Coeur d'Alene River basin with the discovery of silver in 1884. Soon after, mines, mills, and towns began to alter the landscape of the Coeur d'Alene River basin. The Bureau of Land Management has identified approximately 1,080 mining or milling features within the basin that are a result of mining activity. Over the years, improvements have been made to mining technologies, transportation, concentration techniques, and the handling of waste products from mining activities, all of which have affected the Coeur d'Alene Basin and its inhabitants.

Much of the ore produced in the basin required concentration before smelting. The first mill in the basin, associated with the Bunker Hill mine, began operations in 1886. Initially, ores were concentrated by pulverization and gravity separation. In 1912, flotation milling was introduced to the basin. Flotation milling involved finer pulverization of ores and mixing them with water and an oil or grease flotation material. Flotation milling greatly enhanced the efficiency of minerals recovery, so the remaining tailings had lower concentrations of valuable minerals than did the "jig" tailings that resulted from the earlier processes.

Mills were constructed near sources of surface water because milling required large volumes of water. Many of the mills were located in steep narrow canyons with little area available for tailings disposal, so tailings were discharged to the streams or sluiced to the South Fork. Mills along the South Fork discharged most processing wastes directly to the river. Tailings dumped in the floodplain often subsequently eroded to the stream.

The quantity of tailings discharged constitutes a substantial amount of material. Estimates of the total amount of tailings discharged to the South Fork Coeur d'Alene River and its tributaries range from 54.5 to more than 70 million tons, depending on the source (Long 1998; Mine Systems Design Inc., as cited in Shoshone Natural Resources Coalition 2000; MFG 1992). A 1998 estimate of 61.9 million tons developed by the U.S. Geological Survey (Long 1998) is believed to be the most accurate and falls near the midpoint of the range of estimates. Assuming that 1 cubic foot of tailings weighs approximately 125 pounds, if all the tailings were piled on a football field (100 yards by 50 yards), the pile would reach more than 4 miles high. Recognizing that the tailings discharged to the river have been commingled with clean sediment, which then itself becomes contaminated, the total amount of contaminated material in the Basin is significantly greater than 61.9 million tons.

Tailings were transported downstream and deposited on the floodplains, banks, and beds of the Coeur d'Alene Basin. Jig tailings, which were sand-sized particles, settled rapidly on the banks of the creeks in which they were deposited. Seasonal high flows flushed the jig tailings downstream. Flotation tailings had a fine silty texture and were readily transported downstream. Jig and flotation tailings were transported downstream and deposited on the floodplains, banks, and beds of the Coeur d'Alene Basin.

In the late 1960s, tailings impoundment became the standard practice, and subsequent releases to streams have been limited mainly to lateral erosion of historic tailings piles and redistribution of tailings released previously. Tailings impoundments continue to release metals-contaminated water to surface water and groundwater, but in response to requirements of the Clean Water Act, the releases to surface waters from permitted impoundments have been greatly reduced over time.

Environmental Setting

The Coeur d'Alene Basin originates near the Idaho-Montana border and extends westward, draining approximately 2,360 square miles of the western slope of the Bitterroot Mountains. The North and South Forks are rocky, high-gradient streams in narrow valleys confined by steep hillsides. The North and South Forks come together near Enaville to form the main stem, which

is a fine-substrate, low-gradient meandering river in a broad valley. In this valley, 12 shallow lateral lakes and thousands of acres of wetlands and other floodplain habitats are hydraulically connected with the main stem. The main stem flows into Coeur d'Alene Lake near Harrison. Coeur d'Alene Lake discharges through the Spokane River, which is a tributary of the Columbia River.

It is not feasible to evaluate ecological risks to every plant, animal, and microbial species that may be present and potentially exposed within the Coeur d'Alene Basin. Consequently, receptors of high ecological or societal value or those believed to be representative of broader groups of organisms were selected for evaluation. Representative ecological receptors were selected on the basis of current information on habitat types present and potential for exposure in the Basin. Each receptor was chosen to represent a trophic category and particular feeding behaviors (e.g., diving birds versus shorebirds) that would represent different modes of exposure to COPECs. Thus, the species that were chosen for evaluation may represent hundreds of similarly exposed species in the Basin. The following criteria were used to select potential receptors:

- The receptor does or could use habitats present in the Basin.
- The receptor is important to either the structure or function of the ecosystem.
- The receptor is statutorily protected (i.e., threatened or endangered species, migratory birds) or is otherwise highly valued by society (i.e., species of cultural importance).
- The receptor is reflective and representative of the assessment endpoints for the Coeur d'Alene Basin.
- The receptor is known to be either sensitive or highly exposed to COPECs in the Coeur d'Alene Basin.

Where appropriate, the same receptors were used for more than one CSM unit to increase efficiency and consistency of the EcoRA and to allow for the comparative evaluation of CSM units (Table ES-1).[b] Many of the receptors selected for evaluation are listed here for the different habitat types.

Within the Basin, ecological risks associated with mining-related hazardous substances were evaluated within six habitat types. The occurrence of these habitats within different portions of the Basin varies, and the typical species associated with the habitats also vary from one portion of the Basin to another. The habitats and a few typical species include the following:

- **Riverine** habitat includes the wetlands and deepwater habitats within the channels of creeks and rivers of CSM Units 1, 2, 3, and 5. Typical fish expected to occur in this habitat include westslope cutthroat and bull trout, sculpin, mountain whitefish, and, in some portions of the Basin, introduced species such as rainbow, brook, and brown trout. In lower-elevation areas typical fish species include chinook salmon, smallmouth bass, northern squawfish, and sucker. Characteristic wildlife species

[b] All tables within a section immediately follow the figures for that section.

include salamanders, common merganser, osprey, bald eagle, spotted sandpiper, American dipper, water shrew, raccoon, mink, and river otter.

- **Lacustrine** habitat includes wetlands and deepwater habitats that occur in depressions (such as the lateral lakes and Coeur d'Alene Lake) or in dammed river channels (such as the Spokane River upstream of Post Falls Dam). Most plants occur as phytoplankton or as submerged vegetation. Typical fish include many of the same ones as in riverine habitat, plus the largemouth bass, yellow perch, and northern pike. Characteristic birds and mammals include tundra swan, lesser scaup, common goldeneye, common merganser, osprey, bald eagle, tree swallow, little brown myotis (bats), and river otter.

- **Palustrine** habitat includes wetlands that are dominated by trees, shrubs, and other persistent emergent wetland plants. This habitat occurs in smaller areas within CSM Units 1, 2, 4, and 5, relative to larger areas within CSM Unit 3. Typical plants include wild rice, water potato, equisetum (horsetail), cattail, cottonwood, and willow. Characteristic wildlife species include spotted frog, salamanders, great blue heron, Canada goose, tundra swan, wood duck, mallard, bald eagle, common snipe, little brown myotis (bats), raccoon, mink, beaver, muskrat, and white-tailed deer.

- **Riparian** habitat is terrestrial habitat that is associated with one of the previously mentioned wetland habitats, most often the riverine habitat. It occurs along stream channels and around lakes within CSM Units 1, 2, 4, and 5, but is much more extensive in CSM Unit 3. Typical plants include reed canary grass, cow-parsnip, spiraea, cottonwood, alder, and willow. Common wildlife include salamander, spotted frog, northern harrier, American kestrel, wild turkey, great horned owl, Swainson's thrush, American robin, song sparrow, shrew, long-legged myotis (bats), raccoon, mink, white-tailed deer, muskrat, mice, and vole.

- **Agricultural** habitat includes portions of CSM Unit 3 that are used mostly for pasture and hay fields. Redtop, reed canary grass, oats, and barley are typical plants in this habitat, which may be seasonally flooded and used by waterfowl and other wetland species. Common wildlife species include Canada goose, northern harrier, wild turkey, common snipe, American robin, shrew, white-tailed deer, mice, and vole.

- **Upland** habitat occurs outside the floodplains of the creeks and the South Fork within CSM Units 1 and 2. Typical plants include grasses, shrubs, pine, hemlock, red cedar, Douglas-fir, and Rocky Mountain maple. Representative birds and mammals include American kestrel, ruffed grouse, wild turkey, great horned owl, Swainson's thrush, shrew, mule deer (which also serves as a surrogate for elk), mouse, and vole.

Some of the species mentioned above are considered to be "special-status species" for the EcoRA. These include federally listed endangered or threatened species, those identified by the U.S. Fish and Wildlife Service as species of concern, state-listed sensitive plant species, and culturally significant plant species. Examples include the bald eagle, black tern, gray wolf, lynx, bull trout, westslope cutthroat trout, spotted frog, Ute ladies'-tresses, and water potato.

Chemicals of Potential Ecological Concern

The media evaluated in the EcoRA include sediment, soil, and surface water. Groundwater, although contaminated in the Basin, was not evaluated. Animals do not come into contact with it, and the exposure of plants could best be evaluated through concentrations of COPECs in the soil (i.e., reference toxicity data are not available for evaluation of plant exposures to groundwater). Groundwater interacts with surface water, which has been evaluated in this EcoRA. The COPECs for the Coeur d'Alene Basin were tentatively identified during the evaluation of nature and extent of contamination in the draft Technical Work Plan for the RI/FS. The following COPECs were carried forward to the EcoRA and are the focus of all subsequent evaluations in this report:

- Sediment - arsenic, cadmium, copper, lead, mercury, silver, and zinc
- Soil – arsenic, cadmium, copper, lead, and zinc
- Surface water - cadmium, copper, lead, and zinc

ECOLOGICAL MANAGEMENT GOALS AND ASSESSMENT ENDPOINTS

Ecological management goals, assessment endpoints, and measures for the Coeur d'Alene EcoRA are described in Section 2.2. The ecological management goals, assessment endpoints, and measures were developed through consultation with the EcoRA Work Group, and are consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and EPA guidance. The ecological management goals are:

- Maintenance (or provision) of soil, sediment, water quality, food source, and habitat conditions capable of supporting a "functional ecosystem" (as defined below) for the aquatic and terrestrial plant and animal populations in the Coeur d'Alene Basin

- Maintenance (or provision) of soil, sediment, water quality, food source, and habitat conditions supportive of individuals of special-status biota (including plants and animals) and migratory birds, protected under the Migratory Bird Treaty Act, likely to be found in the Coeur d'Alene Basin

These ecological management goals include the need to reduce the toxicity and/or toxic effects of hazardous chemicals released by mining activities to ecological receptors within the Basin, and also the need to provide habitat conducive to the recovery of special-status species. By protecting the integrity of the food chain, water, and other natural resources, as well as habitat structure, the ecological management goals should be fulfilled. The ecological endpoints to evaluate these objectives are summarized below.

Assessment endpoints for the Coeur d'Alene Basin were developed in collaboration with the EcoRA Work Group, and are consistent with the NCP and EPA guidance. The selection of the assessment endpoints is crucial to the EcoRA because they define the important ecological values that are to be protected. They are developed on the basis of known information concerning the contaminants present, the receiving site, and the risk management goals. The assessment endpoints for the Coeur d'Alene Basin are based on the following principal criteria:

- Ecological relevance
- Political and societal relevance
- Susceptibility to known or potential stressors
- Consistency with ecological management goals

The protection of assessment endpoints for the Coeur d'Alene Basin as a whole will be considered to result in a "functional ecosystem" if soil, sediment, water quality, food source, and habitat conditions are capable of supporting natural populations of plants and animals; there are no direct adverse effects on migratory birds or special-status species; and habitat conditions are conducive to recovery of special-status species. Assessment endpoints were developed for four levels of biological organization: individual; population; community; and habitat, ecosystem, and landscape. Assessment endpoints for each level are described in the following text.

Assessment endpoints were identified on the basis of potential effects on ***individuals*** of migratory birds and threatened or endangered species within the Coeur d'Alene Basin. The effect levels for these endpoints were established to eliminate adverse effects to individuals by considering no-effect or minimal-effect levels of metals for the receptor species.

Assessment endpoints that pertain to potential effects on ***populations*** of species that are characteristic of natural habitats within the Basin were identified for the following: fish, amphibians, birds, mammals, and special-status plants (e.g., those that have cultural significance and those that are of special concern to state or federal agencies). Effect levels for these endpoints were established to eliminate adverse effects that may be experienced by $\geq$20 percent of the naturally occurring populations.

Assessment endpoints also were identified that pertain to potential effects within the Basin on aquatic and terrestrial plant and invertebrate ***communities*** that are characteristic of natural habitats in the region. The effect levels for these endpoints were established to eliminate adverse effects to organisms that make up aquatic and terrestrial plant and invertebrate communities.

In addition, assessment endpoints were identified that pertain to potential direct and indirect effects of mining-related hazardous substances on ***habitats, ecosystems, and the landscape*** within the Coeur d'Alene Basin for the following: soil processes (based on viability and sustainability of the soil microbial community to support nutrient cycling and other ecosystem processes necessary for higher plants and animals), and physical and biological characteristics (landscape attributes necessary for sustaining plant and animal communities).

These assessment endpoints were evaluated through a series of measures (sometimes referred to as measurement endpoints) described in the Analysis section.

ANALYSIS OF ECOLOGICAL RISK

Three categories of measures were evaluated during the analysis phase: measures of exposure, measures of effects, and measures of ecosystem and receptor characteristics. The measures are described in the following text.

Exposure Analysis

The exposure analysis evaluated the contact or co-occurrence of mining-related hazardous substances and the assessment endpoint receptors. The measures of exposure used in the EcoRA were developed for each of the assessment endpoints and habitats within each of the CSM units. They included concentrations of COPECs in soil-sediment, surface water, and biota (plants and animals) to which the receptors could be exposed.

The potential routes of exposure indicate the means by which chemicals are transferred from a contaminated medium to ecological receptors. The routes by which ecological receptors may be exposed to COPECs in the Coeur d'Alene Basin include:

- Birds and mammals - ingestion of soil-sediment, surface water, and food
- Fish - ingestion and direct contact with sediment and surface water
- Benthic invertebrates - ingestion and direct contact with sediment or surface water
- Aquatic plants - root uptake and direct contact with sediment and surface water
- Amphibians - direct contact with surface water and soil-sediment
- Terrestrial plants - root uptake from soil-sediment
- Terrestrial invertebrates - ingestion and direct contact with soil-sediment
- Soil processes - direct contact of microbes with soil-sediment

Ecological Effects Analysis

Two kinds of measures were evaluated for ecological effects: (1) measures of effects and (2) measures of ecosystem and receptor characteristics. Measures of effects are the quantifiable changes in an attribute of an assessment endpoint in response to a stressor. As with the measures of exposure, the measures of effect were developed for each of the assessment endpoints and habitats within each of the CSM units. The measures of effects also are defined according to the potential exposure media within each of the habitats in each CSM unit. The measures of effects are briefly stated as:

- Effects on health, survival, or reproduction of migratory birds or on special-status animal species at the individual level
- Effects on survival, reproduction, or abundance for fish, amphibian, avian, mammalian, or special-status plant species at the population level
- Effects on aquatic or terrestrial plant community composition, density, species diversity, or community structure

- Effects on aquatic or terrestrial invertebrate community composition, abundance, density, species diversity, or community structure

The analysis of effects was based on information from: (1) single-chemical laboratory toxicity (dosing) studies; (2) toxicity testing using soil, sediment, or water from the Coeur d'Alene Basin; (3) literature-derived toxicity data; and (4) field studies in the Basin.

Measures of ecosystem and receptor characteristics are factors that influence the behavior and location of ecological entities of the assessment endpoint (such as fish), the distribution of a stressor (such as water temperature), and the life-history characteristics of the assessment endpoint (such as reproduction) that may affect exposure in response to the stressor. Examples of these measures include bank stability, substrate composition and mobility, water temperature, spatial distribution and connectivity of habitat, riparian vegetation habitat quality, sediment deposition rate, and turbidity (total suspended solids). These measures were evaluated for their potential effects on identified receptors, including habitat for special-status or other species.

Evaluation of these measures was based on results from a number of studies conducted within the Basin, primarily CSM Units 1, 2, and 3. It focused on the relationships between mining-related hazardous substances and the indirect effects those stressors have had on physical and biological conditions within the Basin.

Characterization of Ecological Risk

The risk characterization phase of the EcoRA combined the results of the exposure analysis with those from the ecological effects analysis to determine which stressors posed risks to which receptors (assessment endpoints). Determination of risk to receptors is performed by weight-of-evidence evaluation. The strengths, weaknesses, and relative power of each piece of available information (i.e., line of evidence) are considered individually and in combination to develop conclusions concerning the presence or absence of risks. For the chemical stressors, the results are presented as tables and graphs that show the frequency at which COPEC concentrations exceed the various potential effect levels for the different receptors. For physical and biological stressors, the results describe portions of the Basin where adverse effects that are secondarily related to hazardous substances occur within various portions of the Basin. Results of the risk characterization are summarized in the Conclusions section.

CONCLUSIONS

High concentrations of metals are pervasive in the soil, sediment, and surface water in the Coeur d'Alene Basin, and these metals pose substantial risks to the plants and animals that inhabit the Basin. Conclusions concerning the nature and extent to which these COPECs present risks to ecological receptors within the Coeur d'Alene Basin were based on the weight-of-evidence analyses. The general conclusion is that heavy metals, primarily lead and zinc, present significant ecological risks to most ecological receptors throughout the Basin (Table ES-2). Few receptors were identified for which no ecological risks are estimated. In all receptor classes, ecological risks from at least one COPEC in at least one area of the Basin were identified. Because multiple lines of evidence were available for evaluation of risks for some receptors in all receptor classes

(except soil invertebrates and soil microbial processes), the strength of many risk conclusions is considered to be high. Brief summaries of the available lines of evidence and risk conclusions for each receptor class are presented below. As mentioned previously, the receptors that were evaluated in the EcoRA, and for which results are summarized, are representative of hundreds of species that are similarly exposed.

Birds

- Risks to health and survival from at least one metal in at least one area were identified for 21 of 24 avian representative species.
- No risks were identified for ospreys, bald eagles, and northern harriers.
- Lead and zinc present the greatest risks to birds in the Coeur d'Alene Basin, with risks to at least one avian receptor estimated for 11 and 10 of 13 areas, respectively, in the Coeur d'Alene Basin that were evaluated. Risks from these COPECs are not only spatially widespread, but also are broadly distributed taxonomically and of great magnitude.
- Risks from cadmium, copper, and mercury were spatially and taxonomically much less broadly distributed and of lower magnitude, although they presented risks to at least one bird receptor in 5 (for cadmium), 3 (copper), and 1 (mercury) of the 13 areas.
- Arsenic did not present a risk to any avian receptor in any location in the Basin.
- Strength of risk conclusions, as determined by the abundance, quality, and concurrence of available lines of evidence, was high for eight avian species (Canada goose, tundra swan, wood duck, mallard, osprey, bald eagle, northern harrier, and great horned owl), moderate for five (American kestrel, spotted sandpiper, American dipper, American robin, and song sparrow), and low for eleven species (great blue heron, lesser scaup, common goldeneye, common merganser, ruffed grouse, wild turkey, common snipe, black tern, belted kingfisher, tree swallow, and Swainson's thrush).

Mammals

- Risks to health and survival from at least one COPEC in at least one area were identified for 12 of 18 mammalian receptor species.
- No risks were identified for fisher, wolverine, river otter, gray wolf, lynx, or beaver.
- No single COPEC stands out as a predominant risk driver for mammals. Zinc, lead, and arsenic were the most common risk drivers, presenting risks within at least one CSM Unit or segment in the Coeur d'Alene Basin for 9 of 18 receptors for zinc, 8 of 18 receptors for lead, and 7 of 18 receptors for arsenic.

- Cadmium, copper, and mercury presented risks within at least one CSM Unit or segment in the Coeur d'Alene Basin to 2, 4, and 3 species, respectively. Only in CSM Unit 3 did any COPEC (zinc) present a risk to 50 percent or more of all mammalian receptors. Arsenic, cadmium, copper, and mercury did not present a risk to more than 25 percent of receptors in any area.

- Spatially, risks from zinc were most widespread (9 of the 13 areas) and copper the least widespread. Lead, cadmium, arsenic, and mercury posed risks in 8, 6, 5, and 5 areas, respectively.

- With the exception of receptors for which no risks were identified, the strength of risk conclusions, as determined by the abundance, quality, and concurrence of available lines of evidence, was generally low for most mammalian receptors. This is because few lines of evidence were available for most mammals and, when multiple lines of evidence were available, there was generally little concurrence. Conversely, given the generally conservative nature of the exposure models, risk conclusions for receptors estimated not to be at risk (fisher, wolverine, river otter, gray wolf, lynx, and beaver) are considered strong.

Fish and Other Aquatic Organisms

Review of the available evidence of risks to aquatic receptors (fish, invertebrates, and plants) leads to the following conclusions:

- Exposure of aquatic organisms to metals was confirmed by the presence of elevated concentrations of metals in the tissues of fish, invertebrates, and plants in many portions of the Basin.

- Some fish species (e.g., sculpins) are absent from areas of high metals concentrations.

- Based upon comparison of metals concentrations and acute AWQC, surface waters are commonly lethal to some aquatic life in the following areas: upper Beaver Creek, Big Creek, Canyon Creek, Ninemile Creek Segments 2 and 4, Pine Creek Segments 1 and 3, Prichard Creek Segments 1 and 2, the entire South Fork Coeur d'Alene River, and the Coeur d'Alene River down to Harrison.

- Toxicity testing using water from heavily contaminated portions of Canyon Creek and the South Fork indicated that substantial dilution with clean water (10-fold, or more) is required to eliminate acute toxicity, consistent with the findings of the surface water-to-AWQC comparisons listed above.

- Based upon comparison of metals concentrations in surface waters and chronic AWQC, growth and reproduction of surviving aquatic life would be substantially reduced in the following areas: Big Creek; Canyon Creek Segments 3, 4, and 5; Ninemile Creek Segments 2 and 4; Pine Creek Segment 1; Prichard Creek Segments 1 and 2; the entire South Fork Coeur d'Alene River; and the Coeur d'Alene River down to Harrison.

- Site-specific toxicity testing and/or biological surveys indicate lethal effects of waters or reduced populations of aquatic life in lower Canyon Creek, lower Ninemile Creek, and the South Fork from Canyon Creek to Enaville.

- Because the bull trout and westslope cutthroat trout are evaluated on an individual level due to ESA coverage, and toxicity can occur at levels below the AWQC, there may be areas where the AWQC is not protective of these species. This is particularly true in areas where there may be low hardness.

- Concentrations of metals in water exceed chronic ambient water quality criteria by some amount in virtually all areas assessed that are downstream of sources of mining waste, indicating some adverse effects on growth and reproduction of aquatic life in all areas.

- Biological surveys in the Spokane River have suggested that metals toxicity contributes to high mortality rates of trout.

- Toxic effects of contaminated sediment are believed to contribute to adverse effects on aquatic life in Big Creek Segment 4, Canyon Creek, Ninemile Creek, Pine Creek, Prichard Creek Segment 3, the entire South Fork, the Coeur d'Alene River, the Spokane River, and, possibly, some parts of Coeur d'Alene Lake.

- Physical disturbances caused by land alterations, and modifications of stream channels caused by construction of infrastructure, adversely affect the ability of streams to support aquatic organisms in some portions of the Coeur d'Alene Basin. Those factors were considered, in part, by using reference areas as a comparison when evaluating biological surveys and habitat conditions.

- The strength of risk conclusions, as determined by exceedances of criteria, site-specific toxicity tests, and biological surveys, is moderate to high in many CSM units and segments.

Amphibians

- Risks to health and survival from heavy metals are present for three of four species. Cadmium, lead, or zinc (singly or in combination) present risks to spotted frogs, Idaho giant salamanders, and Coeur d'Alene salamanders throughout most of CSM Unit 1 (except for Big, Moon, and Prichard creeks, and the Upper South Fork), and in CSM Unit 2. These salamander species do not occur in CSM Units 3, 4, or 5; no risks were identified for the frogs in CSM Unit 3.

- Available lines of evidence suggest that COPECs in the Coeur d'Alene Basin do not present a significant risk to long-toed salamander populations.

- The strength of risk conclusions, as determined by the abundance, quality, and concurrence of available lines of evidence, is considered moderate for spotted frogs,

Idaho giant salamanders, and Coeur d'Alene salamanders; and high for long-toed salamanders.

Terrestrial Plants

- Available information suggests that exposure to arsenic, cadmium, copper, lead, and/or zinc in CSM Units 1, 2, 3, 4, and 5 may present significant risks to populations of selected plant receptors and to the plant community in general.

- The strength of risk conclusions, as determined by the abundance, quality, and concurrence of available lines of evidence, is considered moderate for Ute ladies'-tresses, cottonwood, willow, and Rocky Mountain maple; low for porcupine sedge and prairie cordgrass; and high for the plant community.

Soil Invertebrates

- Arsenic, cadmium, copper, lead, and/or zinc present risks to the soil invertebrate community in CSM Units 1, 2, 3, and 5.

- The strength of risk conclusions, as determined by the abundance, quality, and concurrence of available lines of evidence, is considered low because only a single line of evidence was available.

Soil Processes

- Arsenic, cadmium, copper, lead, and/or zinc present risks to the soil invertebrate community in CSM Units 1, 2, 3, and 5.

- The strength of risk conclusions, as determined by the abundance, quality, and concurrence of available lines of evidence, is considered low because only a single line of evidence was available.

Physical and Biological Characteristics

Risks to plants and animals also are associated with physical and biological characteristics evaluated in this assessment (see Appendix K). Increased bank instability, changes in stream substrate composition and mobility, increased water temperature (from the loss of riparian vegetation along streams), and habitat fragmentation pose a risk to aquatic organisms in affected riverine habitat of the South Fork and its tributaries. Elevated levels of suspended solids pose a risk to aquatic organisms in the Coeur d'Alene River. Increased sediment deposition rates pose risks to aquatic organisms in affected portions of Coeur d'Alene Lake. Decreased spatial distribution and connectivity of riparian habitat, and habitat suitability, pose risks to wildlife using the affected riparian habitat on the South Fork and its tributaries.

ECOLOGICAL PRELIMINARY REMEDIAL GOALS FOR CHEMICAL STRESSORS

The ecological preliminary remedial goals (PRGs) for chemical stressors are proposed concentrations of metals in environmental media (soil, sediment, and water) that preserve the desired attributes of the assessment endpoints, and below which adverse effects are expected either to be absent or to be within defined limits of effects levels. PRGs are often determined by levels of contaminants that would be protective of the most sensitive ecological receptor that is exposed to a particular medium.

The PRGs need to account for the presence of special-status species and protected migratory birds where the level of protection should be higher (i.e., the acceptable effect threshold is lower) than that sought for population-level, community-level, or landscape-level endpoints. This is accomplished by considering the relative sensitivity of special-status species and migratory birds to metals compared to sensitivity of other species in their group, selecting toxicity test endpoints that offer protection at the individual level as a basis for toxicity reference values (TRVs), or applying a safety factor to TRVs developed using surrogate species. The availability of site-specific information for migratory birds has allowed the selection of TRVs or exposure parameters that reflect the protection of individuals. The availability of site-specific comparative toxicity testing with bull trout has allowed the evaluation of the relative sensitivity of bull trout to metals, compared to the sensitivity of other aquatic organisms.

The PRGs are presented as ranges for the various receptor groups that were evaluated (i.e., birds and mammals combined, soil biota combined, etc.), segregated by the level of assessment (e.g., individual- or population-level) and the medium (e.g., soil or sediment). The PRGs for aquatic organisms are set to cover the group as a whole, with consideration of possible effects on special-status species.

PRGs for birds and mammals that were evaluated at the individual level are based on no observed adverse effect level (NOAEL) values, whereas the lowest observed adverse effect level (LOAEL) or dose causing effects in 20% of test animals (ED_{20}) (i.e., a less restrictive value) was used for receptors evaluated at the population level. Because soil is not the most appropriate source medium for evaluation of risks for all wildlife species, PRGS were developed for representative species on the basis of the habitat types in which they predominantly occur. Species that occur in riparian, agricultural, or upland habitats were identified as "terrestrial" and PRGs were calculated for soil (Table ES-3). Species that occur in riverine, lacustrine, and palustrine habitats were identified as being "aquatic" and PRGs were calculated for sediment (Table ES-4).

PRGs for soil-associated biota (e.g., plants, invertebrates, and microbial processes) were based on published toxicity data from the literature and were based on no observed effect concentrations (NOECs) and lowest observed effect concentrations (LOECs) for each receptor group (Table ES-3).

PRGs for surface water are the national AWQC, adjusted for hardness for specified metals (Table ES-5). All median values for background surface water were below the national chronic criteria (assuming hardness of 30 mg/L as $CaCO_3$). The 95^{th} percentile of the background

dissolved lead concentrations exceeded the national chronic criteria calculated at hardness of 30 mg/L as $CaCO_3$ in the following areas: the Upper South Fork, the Page-Galena mineral belt area, and the South Fork basin as a whole ("entire South Fork"). The 75th percentile of the data exceeded the national chronic criteria in the Page-Galena mineral belt area. These results imply that the national criteria would only be exceeded in a very limited number of mineralized locations in the stated drainages at some times. All of the calculated values for zinc and cadmium, including the 95th percentile (assuming hardness of 30 mg/L as $CaCO_3$), were well below the national criteria. Therefore, the AWQC are used as the PRGs for surface water. In areas of low hardness (e.g., 10 mg/L as $CaCO_3$) the AWQC may not be protective, particularly with respect to special-status species such as bull trout and cutthroat trout.

USEPA recently published an update to the AWQC for cadmium (66 FR 18935; April 12, 2001). In relatively soft waters of the Basin, the updated cadmium AWQC is lower than the 1998 cadmium AWQC used in the EcoRA, and use of the 2001 criterion would result in larger estimated cadmium risks to aquatic biota than the risks identified in the EcoRA.

Sediment PRGs are either toxicity-based or regional background concentrations of metals in sediment in the Basin (Table ES-6). The higher value of either background or the toxicity screening value is recommended as the sediment PRG. On the basis of the determinations of regional variations in soil and sediment upper background values (Appendix B), separate background values for sediment were determined for CSM Units 1 and 2, CSM Units 3 and 4, and CSM Unit 5, respectively.

ECOLOGICAL PRELIMINARY REMEDIAL GOALS FOR PHYSICAL AND BIOLOGICAL CHARACTERISTICS

Qualitative PRGs were developed for physical and biological characteristics (assessed as measures of ecosystem and receptor characteristics, such as stream bank stability, water temperature, etc.) that have been adversely affected by releases of mining-related hazardous substances (Table ES-7). The PRGs for these characteristics describe either a range of conditions found in the Coeur d'Alene Basin prior to mining activities or the range of conditions in these characteristics currently found in selected reference areas. The PRGs are applicable to those CSM units that showed unacceptable risks for the specific physical characteristic.

It is acknowledged that factors other than the release of mining-related hazardous substances also affect the physical characteristics. In addition, remediation of the site to meet the chemical- and media-specific PRGs described above will, in time, move toward achieving the PRGs for landscape characteristics.

USE OF THE ECOLOGICAL RISK ASSESSMENT RESULTS IN REMEDIAL DECISION PROCESS

The results of the EcoRA will provide risk managers with the information needed to make remedial decisions for the areas impacted by the mining releases and to achieve the ecological goals for the Basin. The EcoRA results will be used in the Coeur d'Alene Basin Remedial

Investigation/Feasibility Study to evaluate various remedial alternatives. The PRGs identified in both the EcoRA and human health risk assessments, as well as other relevant information, will be used by risk managers to determine cleanup goals for the Coeur d'Alene Basin. Given that the cleanup goals for metals concentrations may be significantly lower than existing concentrations in the Basin, EPA intends to establish interim benchmarks to gauge the success of the remedial actions that are implemented in the Basin. The success of the remedial actions will be measured by monitoring the concentration of contaminants in the Basin, as well as other physical and biological indicators. Interim benchmarks may be used to evaluate engineering performance of a given action or through evaluation of physical, chemical, or biological parameters. EPA will work with stakeholders to identify appropriate interim benchmarks through the RI/FS process.

TAKE-HOME MESSAGE

This section provides a brief summary of the ecological risk assessment process that was followed for the Coeur d'Alene Basin and its key conclusions. Briefly:

- Through consultation with the EcoRA Work Group, and consistent with NCP and EPA guidance, overall ecological goals and associated procedures for evaluating ecological risks were identified. These included the specific groups and representative species to be evaluated, as well as the data that were available for use in the EcoRA.

- An estimated 54.5 to 70 million tons of tailings were discharged to the Coeur d'Alene River or its tributaries, and these tailings were transported downstream and deposited on the floodplains, banks, and beds of the Coeur d'Alene Basin.

- High concentrations of metals are pervasive in the soil, sediment, and surface water in the Basin, where they pose substantial risks to the plants and animals that inhabit the Basin.

- A large volume of data regarding the impacts of mining-related hazardous substances is available for the Basin and, while some data gaps may persist, there is more than adequate evidence to demonstrate the magnitude of the impacts to the ecosystem.

- Metals, primarily cadmium, lead, and zinc, present significant ecological risks to many ecological receptors throughout the Basin.

- Because multiple lines of evidence were available for evaluation of risks for some receptors in all receptor classes (except terrestrial invertebrates and soil microbial processes), the strength of many risk conclusions is considered to be high.

- Risks to health and survival from at least one metal in at least one area were identified for 21 of 24 avian receptor species. No risks from any COPEC in any area were identified for ospreys, bald eagles, and northern harriers. Cadmium, lead, and zinc present the greatest risks to birds in the Coeur d'Alene Basin. Risks from these COPECs are not only spatially widespread, but also are broadly distributed taxonomically and of great magnitude. Lead and zinc present risks to at least one-half

of the representative avian receptors in 7 and 5 of the 13 CSM units or watersheds, respectively. The maximum LOAEL-based HQ for lead was 387 for the spotted sandpiper; for zinc it was 35 for the song sparrow. Strength of risk conclusions, as determined by the abundance, quality, and concurrence of available lines of evidence was high for 8 avian species, moderate for 5, and low for 11 species.

- Risks to health and survival from at least one COPEC in at least one area were identified for 12 of 18 mammalian receptor species. No risks from any COPEC in any area were identified for fisher, wolverine, river otter, gray wolf, lynx, or beaver. No single COPEC stands out as a dominant risk driver for mammals. Arsenic, lead, and zinc were the most common risk drivers, presenting risks within at least one CSM Unit or segment in the Coeur d'Alene Basin for 7 of 18 receptors for arsenic, 8 of 18 receptors for lead, and 9 of 18 receptors for zinc. Spatially, risks from zinc were most widespread and from copper the least widespread. Only in CSM Unit 3 did any COPEC (zinc) present a risk of equal to at least 50 percent to all mammalian receptors (Table 5-3). Arsenic, cadmium, copper, and mercury did not present a risk to more than 25 percent of the receptors in any area. With the exception of receptors for which no risks were identified, the strength of risk conclusions, as determined by the abundance, quality, and concurrence of available lines of evidence, was generally low for most mammalian receptors. This is because few lines of evidence were available for most mammals and, when multiple lines of evidence were available, there was generally little concurrence.

- Testing indicates that for aquatic receptors (fish, invertebrates, and plants), exposure to metals has been confirmed by the presence of elevated concentrations of metals in the tissues of fish, invertebrates, and plants in many portions of the Basin; metals concentrations in surface water from several upper watersheds are often at concentrations that are lethal to some aquatic life, and they would substantially reduce growth and reproduction of surviving aquatic life in all CSM units and most CSM segments. Substantial dilution with clean water is required to eliminate toxicity.

- Cadmium, lead, or zinc (singly or in combination) present risks to spotted frogs, Idaho giant salamanders, and Coeur d'Alene salamanders throughout most of CSM Unit 1 (except for Big, Moon, and Prichard Creeks, and the Upper South Fork), and in CSM Unit 2. Available lines of evidence suggest that COPECs in the Coeur d'Alene Basin do not present a significant risk to long-toed salamander populations. The strength of risk conclusions, as determined by the abundance, quality, and concurrence of available lines of evidence, is considered moderate for spotted frogs, Idaho giant salamanders, and Coeur d'Alene salamanders, and relatively high for long-toed salamanders (although there are some uncertainties related to population surveys).

- Exposure to arsenic, cadmium, copper, lead, and/or zinc in CSM Units 1, 2, 3, 4, and 5 may present significant risks to populations of selected plant receptors and to the plant community in general. The strength of risk conclusions, as determined by the abundance, quality, and concurrence of available lines of evidence, is considered

moderate for Ute ladies'-tresses, cottonwood, willow, and Rocky Mountain maple, low for porcupine sedge and prairie cordgrass, and high for the plant community.

- Arsenic, cadmium, copper, lead, and/or zinc present risks to the soil invertebrate community in CSM Units 1, 2, 3, and 5. The strength of risk conclusions, as determined by the abundance, quality, and concurrence of available lines of evidence, is considered low because only a single line of evidence was available.

- Arsenic, cadmium, copper, lead, and/or zinc present risks to the soil microbial processes in CSM Units 1, 2, 3, and 5. The strength of risk conclusions, as determined by the abundance, quality, and concurrence of available lines of evidence, is considered low because only a single line of evidence was available.

- Physical stressors also may pose ecological risks to the receptors described above, as well as to their habitat. Riverine habitats within CSM Units 1 and 2 exhibit reductions in the quantity and quality of in-stream habitat that range from minor to severe reductions from increased sedimentation, alterations of stream channels, increased summertime water temperatures (largely because of the loss of stream-bank riparian vegetation that serves to shade stream water), fragmentation of remaining areas of high-quality riverine habitat, and elevated concentrations of suspended solids. In lacustrine (lake) habitats, sediment deposition rates may pose risks to benthic invertebrates through smothering and alteration of habitat in portions of Coeur d'Alene Lake, particularly near the mouth of the Coeur d'Alene River. Riparian habitat in CSM Units 1 and 2 is moderately to severely degraded.

- Ecological PRGs for chemical stressors are proposed concentrations of metals in environmental media (soil, sediment, and water) that preserve the desired attributes of the assessment endpoints, and below which adverse effects levels are expected either to be absent, or at acceptable levels. In setting remedial goals, PRGs are often determined by levels of contaminants that would be protective of the most sensitive ecological receptor that is exposed to a particular medium. Within the Coeur d'Alene Basin, these values were often lower than background values for soil, sediment, and surface water. As a result, the recommended PRGs in the areas where background levels of metals exceed potential effect levels, the PRGs default to the background levels.

- Ecological PRGs for physical and biological characteristics are ranges of conditions found in the Basin prior to mining activities or conditions currently found in selected reference areas.

The results of the EcoRA will be used along with the results of the human health risk assessment to provide risk managers with the information necessary to evaluate cleanup alternatives for the Coeur d'Alene Basin.